Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of

Petition for Waiver to Allow Deployment of Intelligent Transportation System Cellular Vehicle to Everything (C-V2X) Technology	GN Docket 18-357

COMMENTS OF u-blox America Inc.

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I. Executive Summary

The Office of Engineering and Technology (OET) and the Wireless Telecommunications Bureau (WTB) sought comments on the 5GAA petition for waiver to allow deployment of cellular vehicle-to-everything (C-V2X) in the 5.9 GHZ band. The 5GAA, through this petition for waiver, is requesting changing the current rules regarding the allocation of the 5.9 GHz to allow the deployment of Cellular Vehicle-to-Everything, C-V2X, in the upper edge 5.905 – 5.925 GHz, of the 5.850 – 5.925 GHZ (5.9 GHz) band allocated to DSRC.
The 5GAA petition waiver is supporting its request by an attached 5GAA test report claiming "C-V2X offers capabilities today that are superior to those others technologies", namely DSRC.

u-blox thanks greatly the respected OET and WTB commissions for this opportunity to share its comments as highlighted below:

Commitment to a rapid deployment of DSRC, a mature technology for saving lives:
u-blox is strongly committed to public traffic safety through developing the appropriate technologies and contributing to enforce a rapid deployment of such technologies in order to improve the safety of road users, hence saving lives.

DSRC has undergone a decade of extensive pilot programs, field trials, multiple vendor interoperability tests, before the first commercial deployments. Further deployments are on the near horizon, namely from General Motors, Toyota and others. As such imminent deployments will have a direct positive impact on the safety of millions of road users and will enable saving lives**, u-blox urges the commission not to entertain any solutions that will disrupt such deployment**.

A delay in deploying DSRC represents a tragic loss of opportunity for saving tens of thousands of lives in the coming years, as reported by a recent analysis made by the University of Michigan Transportation Research Institute [Ref: 1]. Therefore **u-blox urges the Commission to support a rapid deployment of DSRC without considering taking decisions that will disrupt and such deployment.**

A questionable C-V2X maturity and claimed performance superiority:
During the almost ten years' timespan between DSRC first field trial roll-outs and the recent C-V2X ones, a huge amount of experimental data under numerous environment conditions has been accumulated that cannot be invalidated from a single report like the one attached to this petition.

u-blox strongly believes that the currently limited tests which the C-V2X community have undertaken are not representative in anyway of a single real safety application use case, hence a proper commercial deployment.

Furthermore, the claims of "C-V2X superiority compared to DSRC" are completely misleading as the comparison is based on a biased, unfair, and unrealistic setup that led to rushed conclusions that readily collapse under diligent examination, such as the one conducted by u-

blox [Ref: 2]. **u-blox urges the Commission to ignore the C-V2X marketing noise, and to request C-V2X to undergo a proper maturity path before advancing any claims of superiority.**

Serious interoperability issues:
The petition for waiver does not provide any concrete nor efficient means that will guarantee that LTE-V2X will be able to co-exist and be interoperable with DSRC. Furthermore, it is expected that 5GNR-V2X will not only be unable to co-exist with DSRC, but also with LTE-V2X as expressed in the 5GAA report "*5GNR-V2X will request a new rulemaking to operate on other bands*".

The IEEE 802.11bd evolution path of DSRC, on the other hand, provides a seamless interoperable, coexistent and backward compatible path using the same DSRC spectrum. **u-blox urges the Commission to support only technologies that use the spectrum efficiently.**

Spectrum fragmentation will hamper the traffic safety goals:
Over the past decade, a lot of effort has been dedicated to validate the spectrum requirements to guarantee that the full potential of traffic safety goals are met. The conclusion is that not only the already dedicated 75 MHz band is going to be fully utilized in the near term, as reported by the US-DoT [Ref: 3], but that there is a need to extend this spectrum for future use cases that will build upon day-1 applications, as reported by the Car2Car Consortium [Ref: 4]. **u-blox urges the Commission to i) remain committed to the current 75 MHz spectrum allocation for DSRC, ii) not allow future emerging technology to duplicate any of the traffic safety applications.**

II. u-blox is committed to DSRC and to the development of future traffic safety technologies

u-blox has been and remains committed to developing technologies that will improve traffic safety and contribute into saving the lives of road users. Whether, through its high-precision GNSS roadmap or its V2X roadmap, including both DSRC and C-V2X, u-blox is heavily investing on every wireless technology targeting the automotive industry with the mindset that public traffic safety shall reign regardless of technology.

u-blox strongly believes that DSRC has gone through a clear development path that led to its maturity and readiness in order to dramatically improve the safety of transportation and hence the safety of millions of US road users. Thus, **u-blox respectfully expresses its strong objection against any proposals that disturb the imminent rollout of DSRC**, as planned by major automotive manufacturers, such General Motors, Toyota and others.

u-blox supports the evolution path of IEEE 802.11p, represented by the IEEE 802.11bd Task Group, which offers a seamless evolution path from IEEE 802.11p that is interoperable, backward compatible, and coexistent with DSRC on the same spectrum currently allocated. The 3GPP LTE-V2X (Release 14 and 15) evolution path does however require splitting the spectrum with the upcoming 5G NR-V2X (Release 16), which is against an efficient and optimal usage of the spectrum, and against the commission's policy. **Hence, u-blox urges the**

Commission to support only technologies that guarantee a seamless evolution path without any fragmentation of the scarce spectrum resources.

III. Argumentation on the inappropriateness of the 5GAA petition waiver

The 5GAA petition for waiver has many inconsistencies that are addressed below:

A. Pursuing intervention into the already allocated resources for Public Safety

The 5GAA waiver is not consistent with the UNII-4 sharing proposals proceeding - *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band* -, currently ongoing and driven by the commission since 2013. While, the recent closing report of Phase I does not draw conclusions whether any of the two tested approaches "detect & vacate" and "re-channelization" can reliably avoid harmful interferences to a DSRC device, it strongly indicates the presence of harmful interference with significant implications on an operating DSRC device. **Hence, u-blox takes this opportunity to urge the Commission to remain committed to the additional test phases: Phase II and Phase III**

The 5GAA petition for waiver disregards entirely the fact that the proposed C-V2X devices will not be able to communicate with a DSRC device outside the 5.905 – 5.925 GHz band, nor can it co-exist with a DSRC device on the upper channels by reliably detecting each other and deferring to each other's transmissions. Furthermore, the 5GAA asserts that "*the bandwidth requirements to support more intensive 5G-enabled road safety applications will be much higher*" and is planning to request more spectrum. This foreseeable request is regarded as a consequence of the fact that the "*C-V2X evolution path*" leading to 5G NR-V2X will not be providing a forward and seamless co-existence on the same spectrum. Rather, there will be a need to have both LTE-V2X and 5G NR-V2X running on different spectrums, hence fragmenting even more the spectrum amongst two technologies that are supposed to serve the same purpose, same applications.

On the other hand, the IEEE 802.11bd representing the Next Generation Vehicle (NGV) provides a work scope that allow an NGV device to be forward interoperable, thus able to decode any existing DSRC device, and backward interoperable, thus capable of transmission modes that can be decoded by any DSRC devices. This interoperability and co-existence is all possible on the same channel. **u-blox urges the Commission to disregard the 5GAA waiver as it breaks interoperability with the existing DSRC devices and upcoming 5G NR-V2X.**

B. Superiority claims are falling short of the reality under meticulous analysis

The 5GAA petition for waiver supports its request by a technical report [Ref: 5] advertising claims of "*C-V2X superiority*", such as "*The superior C-V2X capabilities of C-V2X over DSRC*". u-blox scrupulously analyzed this report and came to the following conclusion:

- The methodology used in the 5GAA report promotes a biased and unfair comparison between the two technologies, with the main concerns being:

- **Unrealistic channel utilization:** For C-V2X redundant packets were transmitted using a so-called HARQ mechanism to increase the probability of reception. Using such a mechanism results in a non-efficient use of the air medium, especially in high-mobility condensed-traffic use cases as clearly is shown in u-blox review.

- **Illogical test setup:** Even though the comparison quotes a nominal bandwidth of 10 MHz for both C-V2X and DSRC, the C-V2X device was actually utilizing less than 5 MHz of bandwidth. This resulted in the C-V2X device experiencing a significantly lower noise floor, making the comparison a non-valid one as the C-V2X device was effectively transmitting with twice the power as the DSRC device in this setup.

- The choice of DSRC device: 5GAA has chosen for this comparison a DSRC device which has a very poor sensitivity. U-blox conducted similar tests with a commercially available DSRC device to confirm such finding.

u-blox investigation not only confirmed that **the 5GAA claims of "C-V2X superiority"**, such as *"C-V2X's Superior Reliability Over a Much Greater Communications Range"*, *"C-V2X's Better Non-Line of-Sight Performance"* or *"C-V2X's Superior Resiliency to Interference"* **collapse under a diligent and fair comparison (Appendix A)**, but confirmed also that **a commercial DSRC device provides a significantly better performance under real conditions**. Findings, which have been confirmed and validated by other DSRC players through million days of field testing.

C. Fragmenting spectrum lessens irreparably Safety planning potentials

A fragmentation of the available spectrum already allocated to DSRC will undoubtedly not unfold the full potential benefits of traffic safety applications. Accommodating another technology, C-V2X, on the current DSRC spectrum will not only hamper exploiting the full potential of DSRC, but also of the other technology.
The US-DoT stated in its latest report "*Preparing for the Future of Transportation*" [Ref: 3] that all seven DSRC channels are fully utilized. This statement is confirmed by an assessment made by the Car2Car Communication Consortium which estimates that regardless of the communication technology, the already allocated 75 MHz is required to support applications such as automated driving as collective perception, cooperative maneuvering and truck platooning. **u-blox urges the commission to make decisions avoiding the duplication of any use case with any emerging technologies**.

D. Economic and social impacts for the US industry and the public safety amid allowing multiple safety communication technologies dueling for the same spectrum

The DSRC deployment status in US, even if the 2016 NPRM has been brought to a standstill, is progressing apace as evidenced by the automakers announcements [Ref: 6, Ref: 7, Ref: 8] and the many individual states infrastructure (I2V) roll-outs [Ref: 9]. The accredited for V2X certification industry association (OmniAir) has launched the world's first DSRC-V2X device certification program in 2017 and since then three plug-fests have taken place averaging some 150 attendees with 25-30 DSRC devices tested at each event

[Ref: 10]. The US-DOT has invested $700 million over the past years in research and development funding for V2X [Ref: 3]. Most importantly, up to 8.1 million car crashes and 44,000 deaths could be prevented if the federal government mandated connected vehicle technology now, rather than waiting even three years to develop and evaluate competing technologies [Ref: 1]. DSRC has undergone long perusal and built a multi-disciplinary ecosystem comprising state agencies, industry associations, car manufacturers, tiers-1s and technology providers. Despite the confronted difficulties **it is rapidly gaining momentum that will even increase by a decision from the Commission to protect and preserve the DSRC spectrum.**

IV. Conclusion

In light of the facts discussed above, we urge the Commission to dismiss the 5GAA request for waiver with no delay.

APPENDIX

Review of 5GAA's "V2X Functional and Performance Test Report" P-180106

A Introduction and Summary

A report was recently published by 5GAA where it is claimed that C-V2X "is a superior technology" and that it offers "significant performance advantages … when measured against DSRC".

u-blox has done a thorough analysis of the 5GAA test procedure and results. Not only we find these claims largely exaggerated, but also indicating considerable degradation of on-the-field performance when compared to the lab test results, thus raising serious concerns about the level of maturity of C-V2X overall.

1. The comparison is based on a DSRC device which has significantly worse sensitivity compared to any commercial solution currently being deployed in the market. The level of performance is so low that it is not even compliant with the SAE J2945 standard as claimed in the report.

2. Even though, the comparison quotes a nominal bandwidth of 10 MHz for both C-V2X and DSRC, the C-V2X device was actually utilizing less than 5 MHz of bandwidth. This resulted in the C-V2X device experiencing a significantly lower noise floor. In terms of sensitivity, this translates to an unfair advantage of more than 3 dB in favor of C-V2X.

3. For C-V2X, redundant packets were transmitted using a so-called HARQ mechanism to increase the probability of reception. This however results in inefficient use of the air medium, especially in high-mobility condensed-traffic use cases. Using HARQ, C-V2X was again favored by another 3-4 dB. By combination of the reduced bandwidth and HARQ usage, C-V2X effectively was using up to 8 times higher channel occupancy to transmit the same amount of information as DSRC.

As highlighted above, there are no grounds that support the 5GAA claims of "superior performance of C-V2X". The 5GAA comparison clearly gives an overall advantage of approximately 14 dB for C-V2X, thus making this comparison entirely biased and unfair. In the following, u-blox will share measurements based on its own DSRC commercial chip that will demonstrate that under fair conditions, a competitive DSRC

device provides similar performance with C-V2X under lab conditions and far better performance in field trials.

B Conducted tests

Section 7.2.2 of the 5GAA report outlines the test procedure and results of a conducted measurement under a constant transmit power (20 dBm) and varying levels of attenuation (65 dB to 130 dB). With this configuration, the receiver sensitivity of both devices was evaluated. We see two major issues with the tests setup as described in the following sections.

a. **The tests setup were favoring the C-V2X equipment in an unfair manner**

Even though the nominal bandwidth was quoted as 10 MHz for both technologies, for the case of C-V2X less than half of that was actually utilized, as indicated by the use of 5 sub-channels configuration. Therefore, this measurement gave an unfair advantage to the C-V2X device since the latter would experience a noise level which is more than 3 dB lower than that of the DSRC device. Obviously, using a smaller bandwidth results in the C-V2X message requiring double the air-time, which is not mentioned in the report.

In our view, a fair comparison would involve tests which result in the same occupancy of the wireless medium. The same issue was also experienced with the utilization of the HARQ mechanism which transmits redundant information to improve the reception performance. Again, any fair comparison should ensure that the air time is approximately equal for both technologies, or that the different amounts of air-time is taken into account. For example, a fair metric would be the required energy to transmit a single bit of information under a given noise level (E_b / N_0).

b. The performance of the DSRC equipment used in the report is not representative of competitive DSRC products available today

Having a constant transmit power of 20 dBm and an attenuation of 110dB, implies that a PER of 10% is obtained for a received power of -90dBm at the DSRC unit, which is considered to be the receiver's sensitivity. This value is however more than 8 dB worse than most commercial DSRC systems[1].

On top of this, even though the report is claiming that the DSRC device is compliant with SAE J2945, this level of performance would clearly violate the specifications in this standard which requires a sensitivity of -92dBm with a packet size that is twice the size (400b) than the one used (193b).

[1] CohdaMobility MK5 Module Datasheet (https://fccid.io/2AEGPMK5RSU/User-Manual/User-Manual-2618067.pdf)

Our own conducted tests verify that the performance of a competitive DSRC device is 11-12 dB better than the Savari equipment shown in this report, with the difference from the C-V2X device being only around 3-4 dB (Figure 1). When taking into account the unfair gain provided by the use of the HARQ mechanism, then the performance of the two technologies are almost equivalent. This comes as no surprise since they both use the similar underlying OFDM technologies.

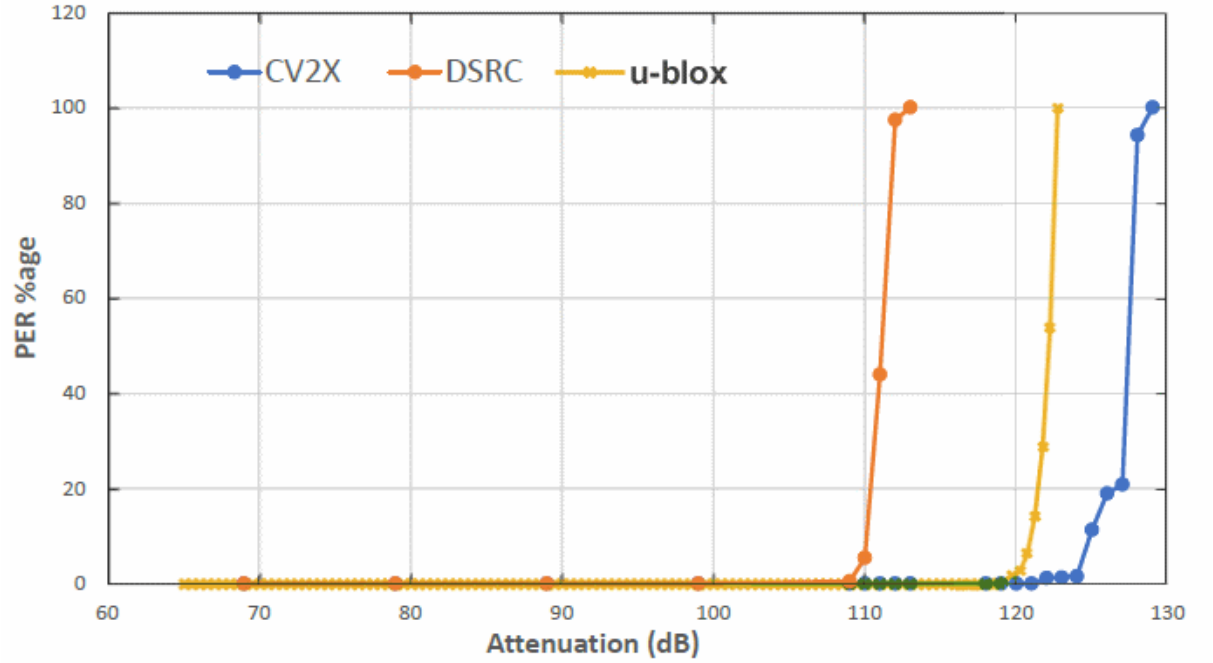

Figure 1: 5GAA (DSRC & C-V2X) vs u-blox (DSRC) conducted tests results

C Test trials

a. Path loss

Section 8.5.1 of the 5GAA report shows the tests from a field trial under Line-of-Sight conditions. In Figure 46 of this report, the RSSI level is plotted. This is shown to follow the predictions from a two-ray propagation model quite closely, as expected in such a scenario. In order to test the claims in this section we have replicated the two-ray conditions as shown in Figure 2 below. This model is used in the next section to relate the distance with the received power.

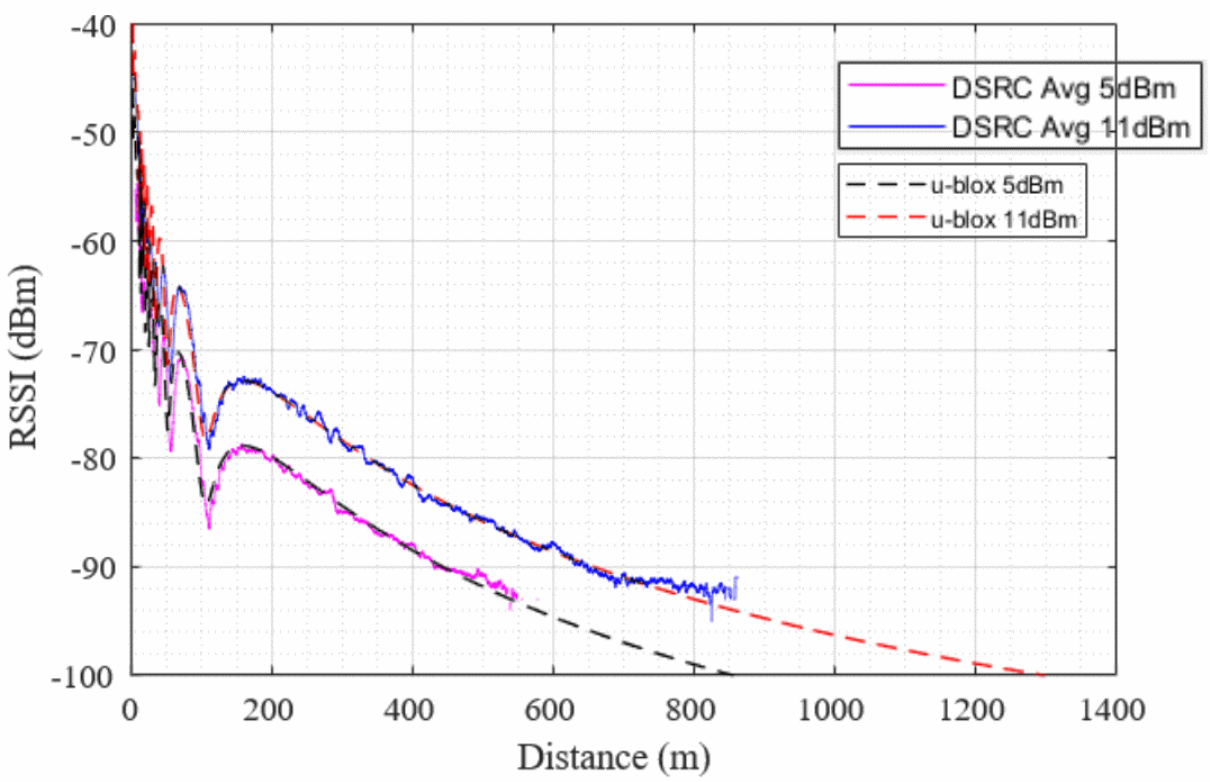

Figure 2: RSSI against distance from 5GAA measurements vs u-blox model

b. Distance measurement

Let's first consider the DSRC results. In the case of 5 dBm transmit power, the PRR is 90% (equivalent to PER of 10%) at a distance of ~460m. At this distance, according to Figure 2 above, the received power level is -90 dBm which is in accordance with the conducted tests previously mentioned. Very similar remarks can be made in the case of 11 dBm transmit power. From these observations, it appears that even though the absolute performance level of the DSRC device was very low, the relative performance between the cabled and trial tests are in agreement.

If we now attempt to apply the same logic to the C-V2X results, we end up in very significant inconsistencies. When a 5dBm transmit power is used, the C-V2X device shows a 10% PER (or 90% PRR) at around 790m. At this distance, the received power level according to the 5GAA measurements is -99 dBm. However, the conducted tests were implying a receiver sensitivity of -104 dBm which demonstrates a 5 dB difference between the lab and test trial results. Similar remarks can be made in the case of 11 dBm transmit power. This is a clear evidence that the C-V2X device, even under fully controlled and favorable conditions cannot provide the benefits claimed by the lab measurements when it comes to operation in the field.

To examine the same scenario with a competitive DSRC device, we plot the expected range of such a device in the following figure. Even if the unfair use of HARQ is not accounted for, the range of operation achieved by the DSRC device is significantly better than that of the C-V2X device.

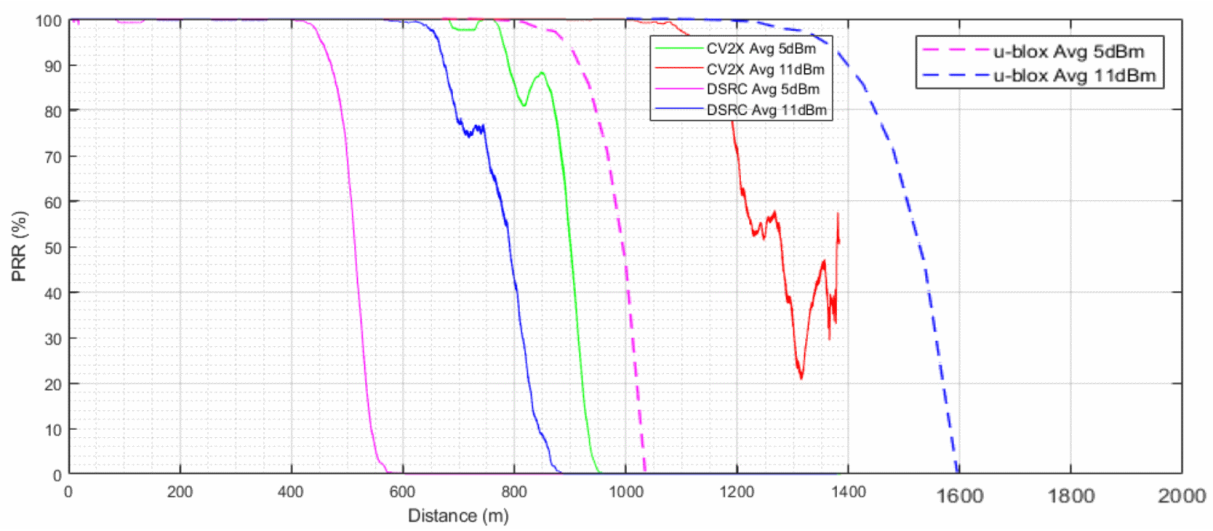

Figure 3: 5GAA LOS field trial results (DSRC & C-V2X) vs u-blox (DSRC)

D Conclusion

u-blox has carried out an in-depth analysis of the test methodology and results presented on 5GAA's "V2X Functional and Performance Test Report". Our findings are that the validity of the claims made in this report are not only false, but reveal significant evidence that the C-V2X technology is unable to perform reliably even under fully controlled and favorable conditions.

When the tests and measurements are replicated in an unbiased manner, the performance of a competitive DSRC device provides similar performance to the C-V2X device in lab conditions and significantly better performance under field trial conditions.